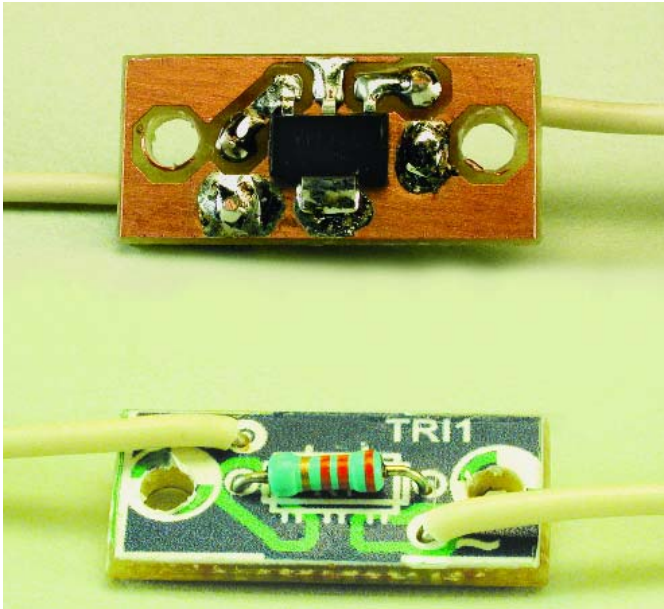


Operating Life Extender for Incandescent Lamps

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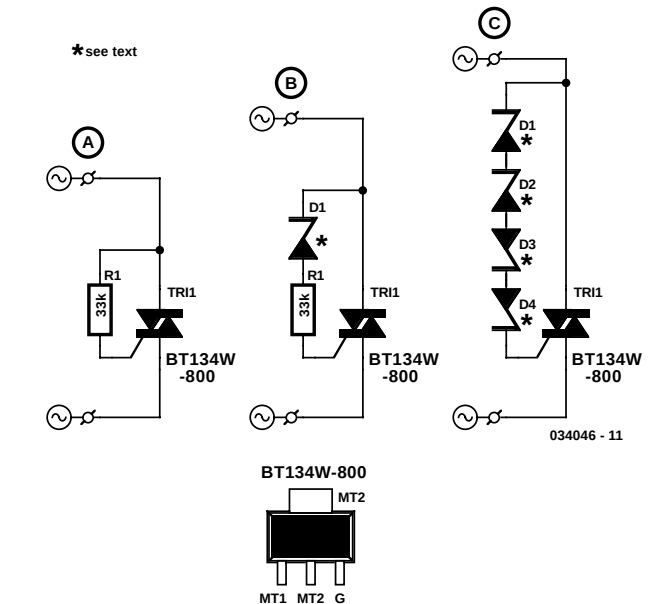


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One way to extend the operating life of incandescent lamps is to reduce the voltage across the lamp by connecting something in series with it. Naturally, a series resistor is the simplest solution, but this produces unnecessary power dissipation. In order to reduce the voltage on a 100-W lamp by approximately 10 V, slightly more than 4 W must be dissipated in the resistor, and that is naturally a waste of energy. A better approach is to use a phase control circuit with a triac controller to reduce to voltage on the lamp. To reduce the voltage on the lamp by 10 V, a phase cut of approximately 44 degrees is necessary. Three ways in which this can be done are presented here.

The simplest version is a triac with a resistor in the gate circuit (**Figure A**). If the voltage on T2 is sufficiently great, the triac will start to conduct. With the indicated type of triac and a 33-k Ω resistor, the voltage is reduced by approximately 10 V. However, the drawback of this approach is that the gate sensitivity of most triacs is different in the various quadrants. For the type shown here, the gate sensitivity is typically 5 mA with T2 positively biased and a positive gate current, while with T2 negatively biased and a negative gate current, it is 11 mA! This results in a DC voltage across the lamp and a 50-Hz component that is just noticeable in the form of a slight flickering. With the tested circuit, the positive triggering threshold was approximately 30 degrees, while the negative triggering threshold was approximately 54 degrees.

A better solution is to add a Zener diode to compensate for the difference in sensitivity. Naturally, this depends on the specific type of triac used. With a positive mains voltage, the diode acts as a Zener, so a higher voltage is required to cause suffi-



cient current to flow through the gate. When the mains voltage is negative, the Zener diode acts as a normal diode, so a specific trigger threshold is reached more quickly. There are various families of Zener diodes with rated voltages up to 100 V (such as the Vishay ZPY100) or even 200 V (the Vishay BZX85C series). If it is difficult to obtain a 100-V type, it is also possible to connect two 47-V Zeners in series.

The 50-Hz and DC components can be nicely reduced using this approach. However, there is still a possibility of asymmetric triggering. An example of this circuit is shown in **Figure B**. In a prototype, the voltage was decreased by around 12 V using a 75-V Zener and a 33-k Ω resistor. With the tested circuit, the positive triggering threshold was approximately 48 degrees, while the triggering threshold for negative voltages was approximately 54 degrees.

If you want to obtain a voltage that is as symmetric as possible, you can connect two or four Zeners in reverse series. With this approach, triggering depends only on the tolerances of the Zener diodes. The circuit shown in **Figure C** illustrates what is meant. Naturally, this can only be used with an incandescent lamp. A DC component is not healthy for fluorescent lamps, and in the case of low-voltage halogen lamps, any DC current flowing through the DC resistance of the transformer could be rather large and even cause saturation of the transformer, with all of the associated nasty consequences.

Now for a few remarks about interference. Naturally, a switched-voltage circuit can generate interference signals. It may be necessary to use an interference-suppression choke, along with a snubber network to protect the triac against transients.

Building the circuit is of course dead easy. If desired, you can

design a small printed circuit board to fit in an existing lighting fixture or plug. However, the circuit can also be built in a separate (tiny) enclosure fitted 'in line' with the mains cable. Be sure to provide adequate isolation separation. Here we have used a type BT134W-800 V triac, which has an SOT223 SMD package and can handle voltages up to 800 V. In the SOT223 package, the tab is intended to be used for cooling. If it is sol-

dered to the printed circuit board, the copper surface of the circuit board acts a heat sink. With this triac, the load must be limited to 100 W. Of course, you are free to experiment with other types of triacs, but remember that when the cable is plugged in, the entire circuit is connected to the mains, and the same applies to any measurement equipment you may be using!